CHAPTER 3

DEVELOPMENT OF HAND GRIP STRENGTH AND ENDURANCE MEASURING SYSTEM

3.1 Introduction

This chapter discusses the methodology used in developing the hand grip strength and endurance measuring system. Firstly, this chapter begins with an overall view of the complete system. In the next section, the selection of main components in developing the hardware is explained. Subsequently the software interface designed using LabVIEW™ that records and export the data to MATLAB® software is described. Next, the process of calibration of this hand grip strength measuring system is explained. This chapter ends with a summary.

3.2 Overview of the System Design

This hand grip strength and endurance measuring device consists of two major sub-systems. The first sub-system is a hardware component which includes the hand gripper. This hand gripper was designed according to the characteristic of hand dynamometer that been used by (Nicolay and Walker, 2005; Nicolay et al. 2008) from Qubit System Inc., Kingston Ontario, as explained in Chapter 2. In addition some modification of handle distances was made according to the optimal grip span size of female Malaysian population. This optimal size is between size two and three of the JAMAR® dynamometer as discussed in Chapter 2. The integration between the hand grip measuring device and the software is depicted in Figure 3.1. Forces exerted during the assessments, were measured using load cell built into the hand gripper. Because of the small direct current (DC) voltage (mV) generated during load cell compression, an amplifier is used.

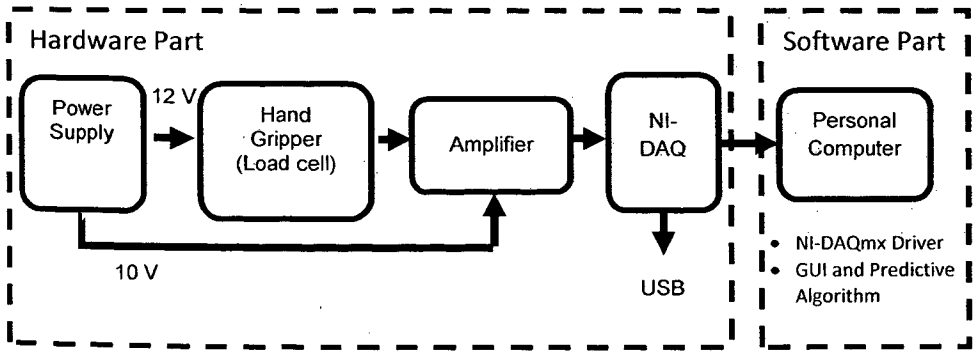

Figure 3.1. Diagram of hand grip strength measurement system

The next sub-system comprises the hand grip software. A National Instrument NI-6008 DAQ (Data Acquisition) card is used to enable communication between the hand grip device and the computer system. The primary function of DAQ is to convert the analog signal to digital signal, and feed it into the computer for further processing. Then, LabVIEW™ data acquisition software (National Instruments) was used to sample and store the voltages measured by the load cell. The Graphical User Interface (GUI) was build using LabVIEW™, as a tool to display the signals and store the desired data. In order to analyze the data and perform HGS and HGE predictives, MATLAB® software is used.

The main feature of this system is its ability to record grip force data throughout the time period of the experiment. The signal recorded over the experimental period is then used to calculate the average grip strength and endurance for further interpretation and analysis (Massy-Westropp et al. 2004).

3.3 Hardware Development

The hardware components used in developing the hand grip measuring device are discussed in the following sub-sections.

3.3.1 Power Supply

A DC power supply is used to power up the main components of the system. It consists of two DC outputs; +10V (to power up the amplifier) and +12V (to power up the load cell). Figure 3.2 shows the block diagram of the power supply. The 12V block contains of the switching power supply unit BWSE12SX-U by ETA-USA. The details of this power supply can be referred at Appendix A1. Meanwhile the block of 10V consists of regulation diagram. The output of 12V will be regulated by LM317 (can be referred at Appendix A2) to obtain a steady 10V DC at its output. Output 10V is calculated as shown in Equation 3.1 I_{ADJ} is typically 50μA and negligible in most applications.

$$Vo = V_{REF}\left(1 + \frac{R_2}{R_1}\right) + \left(I_{ADJ} \times R_2\right) \tag{3.1}$$

A photograph of the fabricated circuit of the power supply is shown in Figure 3.3.

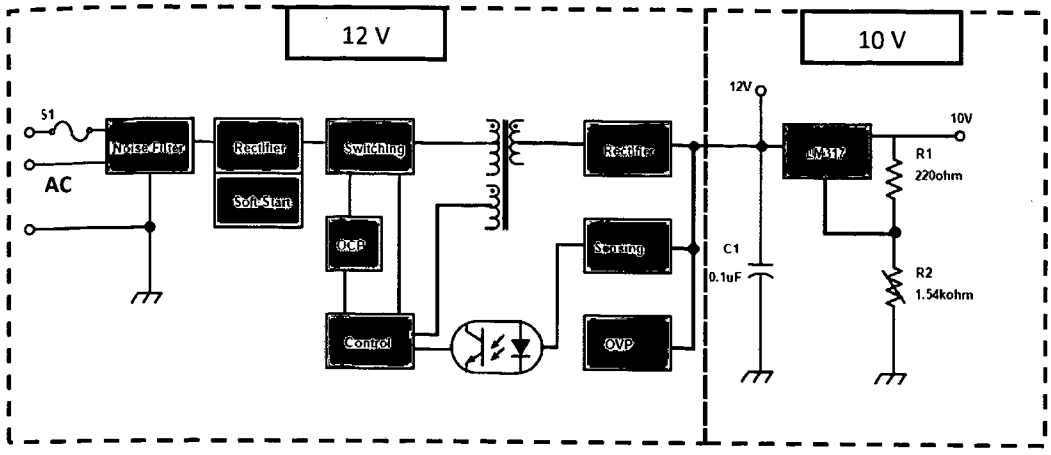

Figure 3.2. Block diagram of power supply

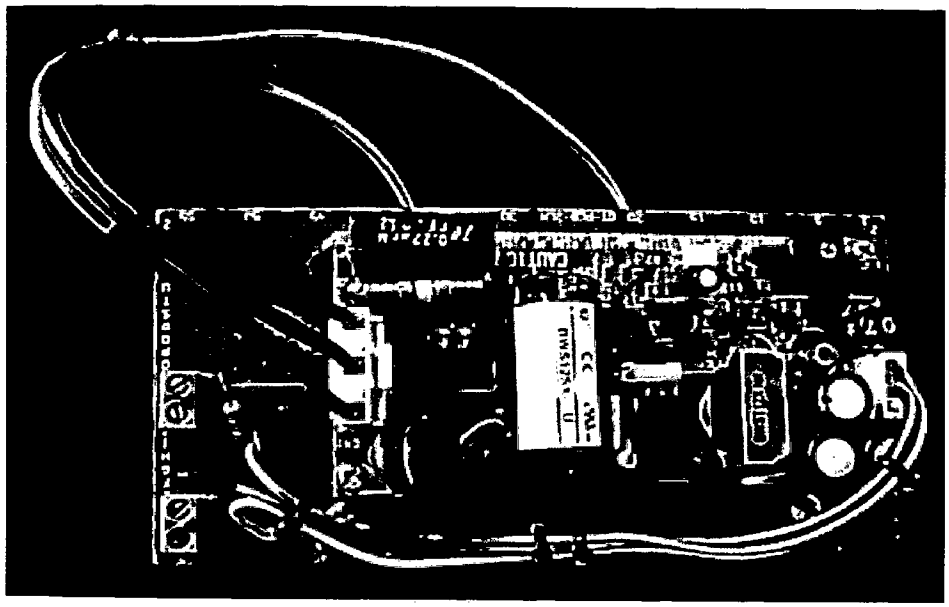

Figure 3.3. DC power supply

3.3.2 Hand gripper

The hand gripper is essentially a sensor that detects hand grip strength exerted by volunteers. This study has developed a hand gripper as shown in Figure 3.4.